Electroless Ni-W-B Coatings: Preparation and Performance Evaluation of Tool Wear in Machining of Maraging Steel

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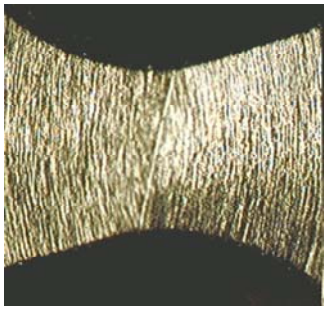
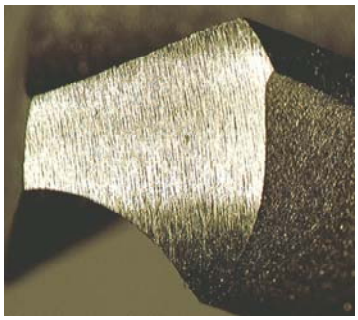
ABSTRACT

Nanocrystalline ternary Ni-W-B coatings have been prepared using DMAB as a reducing agent by electroless plating method. Coatings have been characterized for their morphology, composition, structure, phase transformation behaviour and nanohardness. Coatings have been specifically made on difficult to plate materials like HSS drill bit (6 mm dia.) to evaluate the drilling performance on high strength maraging steel (22 mm thickness) plate with coolant. Pretreatment conditions have been established to get an adherent Ni-W-B coating over HSS drill bits. Surface examination done by field emission scanning electron microscopy (FESEM) study showed that coating exhibited coarse nodular structure. Compositional analysis carried out on the deposit by energy dispersive X-ray analysis (EDAX) and inductively coupled plasma optical emission spectroscopy (ICP-OES) analysis revealed the presence of about 7 wt.% of W, 1.1 wt.% of B with balance Ni. X-ray diffraction (XRD) results showed as-deposited Ni-W-B coating exhibited a broad, single peak at 44° and ascribed to Ni (111). Phase transformation studies carried out on these coatings exhibited an exothermic peak at around 450 °C indicating the crystallization temperature of the coating. As-plated coating exhibited nanohardness value of about 1100 HV_{30mN} and 26% improvement in hardness value was observed for heat treated (400°C/1 h) coating. Drill bit parameters such as feed (130 mm/min.) and speed (1050 rpm) were kept constant during drilling of 50 holes. After drilling, drill bits with and without Ni-W-B coating were examined using Toolmakers microscope to measure the tool wear. Coordinate Measuring Machine (CMM) was used to verify the circularity of holes made on maraging steel. Chisel edge and flank wear of the coated drill bits were found to be reduced of about 67 and 118 µm, respectively compared to uncoated drill bit (Fig. 1). It was also found that Ni-W-B coating had resulted in the improvement of circularity-form error of about 7 µm measured on the drilled holes. Based on the above results electroless ternary Ni-W-B coating seems to be a candidate material to enhance the tool life.

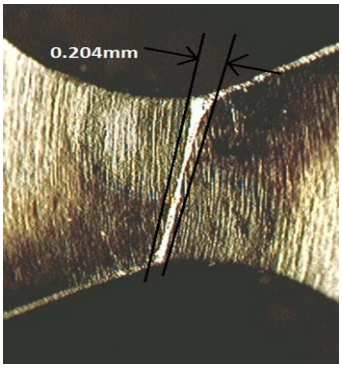
COATED DRILL BIT BEFORE DRILLING

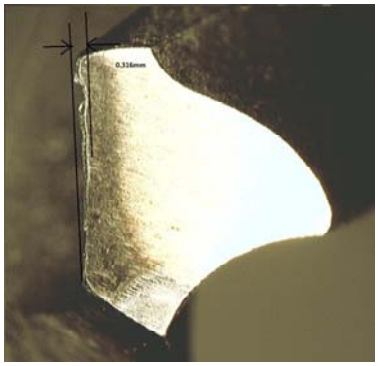




UNCOATED HSS DRILL BIT-AFTER DRILLING 50 HOLES

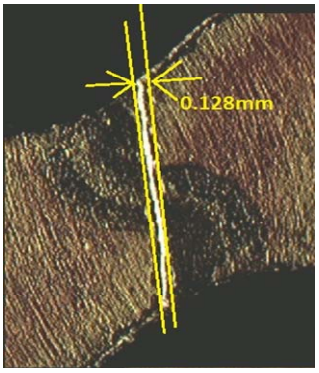
Chisel edge wear **Cutting edge wear**





COATED HSS DRILL BIT-AFTER DRILLING 50 HOLES

Chisel edge wear **Cutting edge wear**



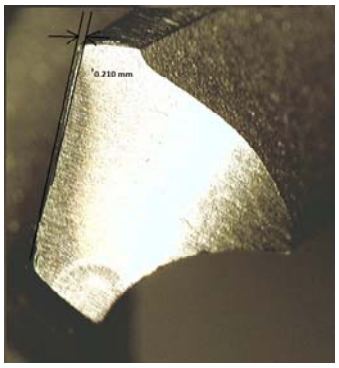


Fig. 1 Drill bit images of coated and uncoated after drilling 50 holes in maraging steel